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ABSTRACT

The effectiveness of problem-solving instruction in promoting high school students' acquisition, retention, and structuring of economics knowledge was studied through six economics classes. The problem-solving instruction model was developed based on problem-based learning in medical education, following similar work by H. S. Barrows and R. M. Tamblyn (1980). Following a two-class pilot study, 80 students in the problem-solving curriculum and 83 in the expository treatment group were taught concepts related to productivity. A knowledge-acquisition instrument and a knowledge-structure instrument were administered. Analysis of covariance and independent t-tests were used to analyze data. No meaningful differences were found between the two instructional treatment groups in either acquisition or knowledge structuring, but limitations in the instruments and attrition in the sample make it impossible to judge the effects of the problem-solving treatment fully. The major significance of the study is the effort to initiate empirical investigation from a cognitive-psychological perspective. Results also suggest that effective acquisition of history and social studies knowledge and the development of higher cognitive skills are compatible and practically feasible. (Contains 40 references.) (SLD)

PROBLEM-SOLVING INSTRUCTION AND STUDENTS' ACQUISITION, RETENTION AND STRUCTURING OF ECONOMICS KNOWLEDGE

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Throughout the history of education, the main missions of educational institutions have been to impart knowledge and to teach cognitive skills (Frederiksen, 1984). The major objectives of social studies education also have centered, to a large extent, around these two goals. Consequently, a vast amount of scholarly effort has focused on how to achieve these goals effectively through classroom instruction.

In recent years, cognitive psychological research, especially research on domain-specific problem solving, has provided a promising theoretical basis for reconceptualizing the problem of teaching and for charting new instructional approaches. More importantly, those studies suggest that teaching for knowledge acquisition and higher-cognitive thought, specifically problem solving, might be compatible (Bransford, Sherwood, Vye, & Rieser, 1986; Glaser, 1984). If this hypothesis is verified, the conventional perception that the effective acquisition of history or social science knowledge and the development of higher-cognitive skills (e.g., problem solving, critical thinking, reflective thinking) are mutually conflicting or practically incompatible (McKee, 1988; Onosko, 1989; Shaver, David, & Helburn, 1979) might become less plausible and prevalent among social studies educators.

Recently, some social studies educators have begun to show a deep interest in the findings of cognitive psychological research on domain-specific problem solving, and to utilize those findings in reconceptualizing the teaching of social studies (e.g., Cornbleth, 1985; VanSickle & Hoge, 1991). An important claim made by those educators is that problem-solving instruction can be an effective instructional alternative for both the development of social science problem-solving skills and the teaching of social science knowledge. A very similar claim was made during the last decade in another educational domain. A group of medical educators proposed a systematic curriculum model, termed problem-based learning, based substantially on cognitive psychological research (e.g., Barrows & Tamblyn, 1980; Birch, 1986; Schmidt, 1983).

However, the arguments supporting these claims are still in their advocacy stage; empirical evidence does not yet exist. We need answers to at least two basic questions: (a) To what extent is the problem-solving approach effective for developing domain-specific problem-solving abilities? and (b) To what extent is the problem-solving approach effective in helping students to acquire domain-specific knowledge (i.e., the subject matter of a field of study)? The study reported here investigated the second question. Specifically, compared to expository instruction, how effective is problem-solving instruction for promoting high school students' acquisition, retention, and structuring of economics knowledge?

A Cognitive-Psychological Approach to Problem-Solving Instruction

Cognitive-psychological research on problem solving focused initially on general strategies that were relatively independent of specific knowledge bases (e.g., Newell & Simon, 1972). Various programs and guidelines for developing students' problem-solving abilities were developed using this perspective. Whimbey and Lochhead's (1980) Problem Solving and Comprehension: A Short Course in Analytical Reasoning, Rubenstein's (1975) Patterns of Problem Solving, Wickelgren's (1974) How to Solve Problems: Elements of a Theory of Problems and Problem Solving, and Hayes' (1989) The Complete Problem Solver are typical examples of this approach. More recent cognitive psychological work on problem solving has focused on the key role of domain-specific knowledge in productive problem solving (e.g., Bransford, Sherwood, Vye, & Reiser, 1986; Glaser, 1984; Voss, Greene, Post, & Penner, 1983).

The attention to domain-specific knowledge resulted in findings that the organization of one's knowedge is also an important determinant of productive problem solving because of the effect of organization on access to previously learned knowledge and recognition of the usefulness of specific knowledge (Chi, Feltovich, & Glaser, 1981; Voss, Greene, Post, & Penner, 1983). However, emphasis on the importance of the organization and accessibility dimensions of one's knowledge, in contrast to the simple acquisition of a certain body of knowledge, makes teaching more difficult. In addition, the newly emerging suggestion that the development of higher-cognitive thought might be achieved most effectively by teaching for it in the context of teaching domain-specific knowledge makes the matter much more complicated. It is not an easy task to develop an instructional prescription in which all these demands are considered seriously.

Cognitive psychological descriptions of the processes of acquiring and retrieving domain-specific knowledge provide insights into the instructional conditions required for effective learning of declarative knowledge. The first condition is activation of prior knowledge (Anderson, 1977; Bransford, 1979; Schmidt, 1982, 1983). Learning domain-specific knowledge has a restructuring character. It presupposes previously learned knowledge that is used in learning new information by establishing some connection between new and prior knowledge

(Bransford, 1979; Schmidt, 1983). Activation of a learner's prior knowledge relevant to subsequent new learning is essential because it enables the learner to process the new information more easily and meaningfully. The effectiveness of a particular instructional design can depend on how well it helps the learner activate prior knowledge (Mayer & Greeno, 1972; Mayer, 1982).

The second condition has to do with elaboration of knowledge, which is related closely to the activation of prior knowledge. Elaboration refers to the process of generating new ideas related to the ideas being received from external sources (Gagne, 1985). In other words, it is the process of adding related prior knowledge to the information being learned. The addition could be a logical inference, an example, a detail, or anything else that can serve to connect information. A large amount of research has demonstrated the value of elaboration processing in the acquisition of declarative knowledge (e.g., Stein, Bransford, Franks, Owings, Vye, & McGraw, 1982). The value of elaboration is its contribution to effective retrieval of stored information. Anderson (1976) suggested that it may provide alternative retrieval pathways along which activation can spread in case one pathway is somehow blocked and others are available. If elaboration facilitates recall of declarative knowledge and learning of new information, it would be useful during instruction to increase the chances that this process occurs. As with activation of prior knowledge, the degree to which students' elaboration is promoted will vary across instructional strategies and will influence their effectiveness..

Another condition for effective learning of domain-specific knowledge is the organization of one's knowledge. Organization is "the structuring or restructuring of information as it is being stored in one's memory" (Ashcraft, 1989, p. 214). Part of the importance of organization derives from the powerful influence it exerts on the process of storing and retrieving information. Cognitive psychologists have documented that well-organized information can be stored and retrieved with impressive levels of accuracy. Gagne (1985) explained the importance of organization for the effective learning and recall of declarative knowledge in two respects. First, organization provides tight connections to the to-be-recalled information so that spread of activation remains in the relevant area of long-term memory rather than spreading away from it. Second, it reduces the short-term memory load by providing a way of keeping track of all the organized information without actually having it all in short-term memory at once.

In addition to the three cognitive psychological conditions for effective learning of domain-specific knowledge, two other conditions are relevant. Selective attention theory postulates that the amount of attention paid to various items of information is a function of the objectives of the people processing the information (Rothkopf, 1970). By presenting a problem whose solution functions as an important objective at the beginning of a learning activity, we are probably able to induce the learners' attention to problem-related information, thus, increasing their learning effectiveness.

Another insight for effective learning is derived from the disappointing results of earlier efforts to teach domain-specific knowledge through instruction that focuses on higher-order thought. Learning by discovery was advocated as a powerful method for teaching meaningful information which in turn would have positive effects on long-term retention and transfer (Bruner, 1961). However, the results of empirical research were not very suppportive (Shulman & Keisler, 1966). Mayer (1975) observed that the disappointing result can be accounted for by the fact that discovery learning does not systematically confront students with new knowledge, a characteristic that is critical to knowledge acquisition. Instead, the student is expected to produce the information himself or herself. Mayer argued that it does not seem reasonable to assume that the student is able to do so without external assistance. Similarly, McKenzie (1979) argued that the flaw of many alternative social studies teaching strategies was their tendency to provide too little information to enable a rational student to discover the ideas he or she is supposed to learn. A problem-solving instruction model must support students' efforts to solve problems by providing them with sufficient new domain-specific knowledge to allow productive problem solving to take place.

The problem-solving instruction model used in the experiment reported here was designed to satisfy these conditions for effective learning of declarative knowledge. It was developed in light of similar work by Barrows and Tamblyn (1980) on problem-based learning in medical education. The model is based on six guidelines for teaching historical or social scientific knowledge in the context of problem solving. (1) Develop a problem situation which has a degree of complexity that can stimulate students' active mental operations and include major aspects of a the knowledge to be taught. (2) Formulate a problem as concretely as possible in writing which students will encounter at the beginning of instruction. (3) Set a sequence of problem-solving tasks with time allocated to each step to guide students' work on the problem. (4) Teach historical or social scientific knowledge with close reference to the analysis of a problem situation initially encountered at the beginning of instruction. (5) Encourage students to utilize the knowledge they have newly learned to solve the initial problem and additional problems. (6) Facilitate open and active group discussions throughout the instructional activities.

There has been considerable empirical research from a cognitive-psychological perspective on learning and problem-solving, but very little research exists on teaching for knowledge acquisiton through problem solving using knowledge and settings that resemble school conditions. Maybe the most relevant empirical study was Schmidt's (1982) experiment on the effects of student problem analysis on text content recall. His study was originally intended to test empirically one of the basic assumptions of problem-based learning (see Barrows & Tamblyn, 1980): Problem-solving experience will promote the learning of new information by activating related prior knowledge and by inducing selective attention to problem-relevant information.

In Schmidt's study, the experimental group was introduced briefly to the various steps of problem analysis first. The major steps introduced and illustrated with an example were: (a) reflection, (b) problem definition, (c) production of explanation, and (d) elaboration. Then, the subjects were presented with a blood cell problem and asked to go through the problem analysis phase following a set sequence which was guided by a tutor. On completion of the problem analysis, both the experimental group and the control group (which had not been presented with a problem) studied a text about osmosis for 15 minutes. Then, they took the reproduction and transfer tests. The result showed that the experimental group significantly outperformed the control group on both reproduction and transfer tests. That is, it was clear that students who experienced problem solving prior to exposure to the new information did much better in acquiring and remembering the new information. The magnitudes of the treatment effect on both tests, which were obtained using Cohen's (1977) formula for effect size, were medium (.64 and .72). The results of the study reported here add to Schmidt's findings about teaching for knowledge acquisiton through problem-solving instruction.

PROCEDURES

Pilot Study

Prior to the main experiment, a pilot study was conducted in order to test the feasibility of implementing the experimental treatments and instruments. Two high school economics classes in a school different than the schools used in the experiment were used. As a result of the pilot study, more detailed instructional plans were developed to guide the teachers, reading materials were revised and shortened, additional work was done to improve the quality of the knowledge acquistion test, and the directions to the knowledge structure test were revised to improve clarity and facilitate students' responses.

Research Design

Random assignment of subjects to experimental and control groups is generally impractical in public school research, because it is very disruptive of the normal classroom procedures and organization. Since random assignment was not possible in the study reported here, one of Campbell and Stanley's (1963) quasi-experimental designs, the nonequivalent comparison group design, was used. Though this design is vulnerable to more threats to internal validity than true experimental designs, it can be used to rule out some plausible rival hypotheses when use of a true experimental design is not possible (Huck, Cormier, & Bounds, 1974). Procedurally, this study followed the pretest-treatment-posttest pattern. The pretest was administered to each group one day before the treatment began. One day after the treatments were finished, the two groups took the posttest along with the knowledge structure test. The retention test was administered with four weeks of delay.

Subjects

Six intact high school economics classes participated in the experiment. The classes were selected from two different schools in the same large, affluent, suburban county school system (four classes from School A and two classes from School B). The economics course offered in each school was required for graduation. In each school, one teacher was responsible for all the economics classes. The teachers were identified by the social studies supervisor and an economics teacher-leader and then interviewed to determine their level of interest in the project. Each school had one additional economics class for high achievers. These classes were excluded from the study to enhance the comparability of the two treatment groups.

There were 163 subjects (80 students in the problem-solving treatment group and 83 students in the expository treatment group). Each class, except the high achiever classes which were not included in this study, was formed somewhat randomly at the beginning of the semester through a computer assignment procedure. The only factor considered in this procedure was time conflicts with other courses in a student's schedule.

Experimental Treatments

Problem-Solving Instruction Treatment. A set of concepts related to the topic of "productivity" was selected as the subject matter content for the problem-solving and expository instruction treatments. Instructional materials for the treatments were developed based on materials produced by the National Council on Economic Education and The University of Georgia Center for Economic Education. Two regular class sessions were used for both treatment conditions.

The problem-solving instructional group's first session started with the introduction of the lesson objectives, rationale, and outlines. This was followed by the presentation of the definition of productivity on a chalkboard with brief examples. Next, the teacher distributed a handout which contained a problem situation involving the need to increase productivity in a hypothetical shoe-making factory. He then allowed a few minutes for students to reflect on the problem. Students were then encouraged to verbalize any ideas which they thought pertained to the solution of the given problem. Since the purpose of this activity was to activate students' prior knowledge, no new information was provided by the teacher. The teacher's main role was guiding group discussion about the problem.

Upon completing the initial problem-solving activities, the teacher distributed the reading material which describes the major ideas related to increasing economic productivity. Students were instructed to review the material individually. When the students finished the reading, the teacher checked their comprehension by asking brief questions about key ideas included in the reading. Then, the students went back to the problem posed at the beginning of the session and worked on it together under the teacher's guidance. Again, the teacher's role and guiding questions were carefully specified.

In reconsidering the original problem situation, the first activity was clarification of terms and concepts included in the problem statement. The teacher asked the students to provide the meaning of key terms and concepts involved. Then, the teacher encouraged the students to develop the problem space by asking questions oriented around the following key questions: What is the initial state? What is the goal state? What kinds of constraints are there?

After this, the teacher led the students to represent the problem. The main focus at this stage was to identify the principal variables fully utilizing subject matter presented in the reading and any additional knowledge students possessed. In order to promote systematic intellectual operations, the teacher guided the students' group discussion by asking questions developed based on Voss et. al.'s (1983) descriptions of reasoning and control operators. Throughout the problem-solving activity, the students were explicitly encouraged to utilize what they had read, and make connections between the reading and potential solutions to the problem.

When the students finished reconsidering the problem, the teacher demonstrated his own thinking process and solutions to the students, and compared and contrasted his and the students' solutions. The first session was concluded by the teacher summarizing the main ideas, especially in terms of solving the given problem.

The second class session of the problem-solving group began with a short review of the content and activities covered in the previous session. Then, the students were given another problem situation which consisted of two parts. The situation was about a productivity problem in a hypothetical landscaping company. The general procedures and elements of emphasis during this session were almost the same as the ones included in the second problem-solving activity in the first session. The second session also ended with the teacher summarizing the main points dealt with in both class sessions. Again, those ideas were illuminated in close connection with the problem-solving contexts in which students participated.

<u>Expository Instruction Treatment</u>. The first session of the expository instructional group began the same way as the problem-solving group--introduction to the lesson objectives, rationale, and outlines. Also, the definition of productivity was provided on a blackboard with examples. Then the students were provided with the same reading material that was used by the problem-solving group. Students were instructed to read the material individually, then the teacher briefly checked on their reading comprehension.

Next, two demonstration activities were performed, instead of problem-solving activities. These activities were related to two of the three major ways to increase productivity; they were about investment in capital goods and in human capital. In the activity demonstrating an example of investment in capital goods, a calculator group and a non-calculator group were compared in terms of the accuracy and speed of arithmetic computations. In the activity demonstrating an example of investment in human capital, the accuracy and speed of card-sorting were compared between the group with special knowledge for faster performance and the group with standard directions. The main purpose of these activities was to expose the students to some of the key ideas related to the concept of increasing productivity by having them engage in actual demonstrations. The first session ended with the teacher's summary of the main ideas with close reference to the demonstrations students performed.

The expository group's second session started with a brief review of major content dealt with during the first session. Then, the students engaged in an additional demonstration activity that was intended to show how specialization and the division of labor contribute to productivity improvement. In this demonstration, one group made envelopes using division of labor while in the other group each student was responsible for making complete envelopes. After the activity, the two groups were compared in terms of the number and quality of envelopes they made. Next, students were given a case study which involves all the key ideas related to increasing productivity. The students' task was to identify those ideas from the story. This activity was implemented both individually and in the group as a whole, followed by the teacher's comments about what they failed to lcoate.

Again, the teacher ended the session by providing a brief summary of the main ideas dealt with during the past two sessions. The critical aspect missed in this treatment in comparison to the problem-solving treatment was the problem-solving component in the learning activities. The reason to term this treatment an expository instructional treatment was that students received new ideas in a predetermined fashion and did not have much opportunity to apply them. In this inquiry, the fundamental difference between this treatment and the problem-solving instructional treatment was the absence of a problem-solving component in the learning of new subject matter knowledge.

Instrumentation

Knowledge Acquisition Instrument. The knowledge acquisition instrument which was used as the pretest, posttest, and retention test consisted of 25 items--16 multiple-choice items, eight true-false items, and one short answer question. The knowledge test was intended to cover comprehensively the major economic concepts and related ideas presented during the instructional treatments. The instrument was fieldtested and revised twice prior to use in the experiment. Even though the internal consistency of this instrument was not as great as desired (.67), it was judged acceptable for assessing differences between groups (Mehrens and Lehmann, 1973). The validity of the instrument was judged by an economic education expert in terms of its relevance to the domain-specific knowledge level instructional objectives of the lessons.

Knowledge Structure Instrument. The knowledge structure assessment instrument was based on the modified ordered tree technique (Naveh-Benjamin, McKeachie, Lin, & Tucker, 1986), which is a modified version of Reitman and Rueter's (1980) original work. A test booklet had four pages, and each page contained the same set of economic concepts which represent a reasonable sample of concepts covered in the instructional treatments. These concepts were presented in a matrix on the top section of each page. Vertical blanks were provided just below the matrix on which the concepts were to be listed by the students. Even though the same concepts were provided on each page, their order in the matrix varied to avoid the effects of response sets.

After the test booklets were distributed, the students were instructed to arrange in a vertical order the given concepts "in such a way that concepts that are closely related in terms of their meaning would appear close to each other" (Naveh-Benjamin et al., 1986, p. 132). Both uncued trial, in which students were told to start with any concept of their choice, and cued trial, in which students were told to start with a specific concept, were used. The purpose of this arrangement was to break stereotyping and encourage variety. Although Reitman and Rueter's (1980) original method used many trials, just four trials were made in this research because Naveh-Benjamin et al. (1986) reported that four trials gave a reliable measure.

After the data collection, each student's ordered tree was obtained from his or her responses using the algorithm developed by Reitman and Rueter (1980). Then, two measures were used to make inferences about the characteristics of a knowledge structure, the amount of organization and similarity. The measure of the amount of organization in an ordered tree was the possible recall order (PRO). "It is the natural logarithm of the number of different recall orders that can be obtained by traversal of a given structure, or, alternatively, of the number of recall orders that contain its chunks" (Reitman & Rueter, 1980, p. 563). In principle, the smaller the PRO, the more organization in the structure.

Similarity means the degree of resemblence between the model structure produced by the researchers and each student's knowledge structure. Technically, McKeithen, Reitman, Rueter, and Hirtle (1981) defined it as the natural logarithm of the total number of chunks the two structures have in common plus one, divided by the natural logarithm of the total number of chunks in both trees plus one. McKeithern et al. (1981) continued that "By dividing the number of common chunks by the total, we construct a proportion of chunks the two trees share" (p. 321). In general, a high value on this measure indicated a high similarity in the content of the two knowledge structures under comparison.

DATA ANALYSIS AND FINDINGS

Two statistical techniques were considered to test the hypotheses of this study: analysis of covariance using pretest scores as the covariate variable and independent t-tests. For several reasons, independent t-tests were chosen to compare means on posttest scores, retention test scores, and knowledge structure scores. Three of the reasons are that students in the classes were assigned by an unbiased process, all students in both treatment conditions had experienced the same previous economics instruction, and the participating teachers reported that their classes were fairly equivalent. The strongest rationale for using independent t-tests was that the treatment groups did not differ to a statistically significant extent on prior knowledge as measured by the pretest.

An independent t-test was performed using pretest scores to assess the initial equivalence of the two treatment groups. The problem-solving and expository treatment group means were 63.10 and 61.88 respectively, resulting in a mean difference of 1.22. At the .05 level of confidence this is not a statistically significant difference (t = .55, df = 161, p =.59). An analysis of the variability in the two groups showed that the variances were homogeneous (F = 1.37, p =.16). The reliability coefficient (Cronbach's alpha) for the pretest was .63. In summary, there was no statistically significant difference in relevant prior economics knowledge between the experimental and comparison groups.

Hypothesis 1: Knowledge Acquisition

Hypothesis 1 explored the difference in immediate knowledge acquisition of students in the problem-solving and expository treatment groups. Data for testing the null hypothesis of no significant difference between the treatment groups were collected one day after the completion of the treatment, using the same instrument employed for the pretest. An independent t-test was performed on the data. Subjects who missed any of the treatment sessions were identified. As a result, 23 students were excluded from the analysis (8 from the problem-solving group and 15 from the expository group). Since there was a possibility that subject loss changed the initial equivalence between the two treatment groups, an independent t-test was calculated, prior to the hypothesis testing, on the pretest scores for those students who actually took the immediate knowledge acquisition test. The result showed that the assumption of initial equivalence was tenable (t = .89, df = 138, p =.38).

Students in the problem-solving treatment group averaged 78.22% correct answers out of a possible 100 percent on the test. The standard deviation for the scores was 12.52. Students in the expository group averaged 72.29% with a standard deviation of 13.91. The analysis resulted in a statistically significant difference in immediate knowledge acquisition test scores at the .05 level of confidence (t = 2.65, df = 138, p =.05). Therefore, this result was in favor of the problem-solving group (mean difference = 5.93), and the null hypothesis was rejected. The reliability coefficient (Cronbach's alpha) for the knowledge acquisition test was .66.

In order to obtain information about the strength of the treatment effect, an effect size was calculated. It was computed by subtracting the mean score of the expository group on the knowledge acquisition test (72.29) from the problem-solving group mean (78.22) and dividing by the expository group standard deviation (13.91). The magnitude of the observed treatment effect was .43. This treatment effect may be interpreted as a medium size magnitude according to Cohen's (1977) guidelines. Stated another way, 67% of the problem-solving treatment group scored above the mean of the expository treatment group.

Hypothesis 2: Knowledge Retention

Hypothesis 2 explored the difference in knowledge retention of students in the problem-solving and expository treatment groups. Data for testing this hypothesis were collected four weeks after the administration of the immediate knowledge acquisition test using the same instrument as the one used for the pretest and the immediate knowledge acquisition test. At the time of the retention test, there were 11 absentees among the subject who took the immediate knowledge acquisition test (eight from the problem-solving group and three from the expository group). Once again, the initial equivalence of the students in the two treatment groups who actually took the delayed retention test was checked. The $\underline{t}$-test of the pretest scores showed that the assumption was tenable ($\underline{t}$ = 1.15, $\underline{df}$ = 127, $\underline{p}$ =.25).

Again, an independent $\underline{t}$-test was performed to test the null hypothesis. The mean score for the problem-solving group was 77.31 percent correct with a standard deviation of 14.29, while the mean score for the expository group was 71.20 percent correct with a standard deviation of 15.91. At the .05 level of confidence, a statistically significant difference was found between the retention test scores of the problem-solving and expository groups ($\underline{t}$ = 2.29, $\underline{df}$ = 127, $\underline{p}$ =.05). The mean difference was in favor of the experimental group (mean difference = 6.11); the null hypothesis was rejected. The magnitude of the observed difference (i.e., effect size) was .38, which can be interpreted as roughly medium size. The Cronbach's alpha reliability coefficient for the retention test was .91.

Hypothesis 3: Knowledge Structuring

Hypothesis 3 explored differences in knowledge structuring of students in the problem-solving and expository treatment groups. Data for testing this hypothesis were collected one day after the completion of the treatments along with the knowledge acquisition test whose result was reported earlier. Students' knowledge structures were inferred using the modified ordered tree technique developed by Naveh-Benjamin et al. (1986). After the ordered trees were obtained for each subject based on the algorithm developed by Reitman and Rueter (1980), two measures were used to infer the characteristics of a knowledge structure: amount of organization (which was measured by Possible Recall Order or PRO) and similarity (which provided a measure of the resemblance between a model tree and a subject's tree).

Independent *t*-tests were performed to test the null hypothesis. There were no statistically significant differences between the problem-solving and expository groups on the two sub-measures of structure (for PRO, $t = .58$, $df = 137$, $p = .56$; for similarity, $t = 1.06$, $df = 137$, $p = .29$). The mean PRO score for the problem-solving group was 8.46 with a standard deviation of 2.93, while the mean PRO score for the expository group was 8.74 with a standard deviation of 2.79. The mean difference of PRO scores between the two groups was almost nil (.28). The effect size of this test was -.1 which means a very samll magnitude of observed treatment effect in favor of the problem-solving group. Smaller PRO values indicate greater amounts of organization in a set of concepts.

The mean similarity score for the problem-solving group was .31 with a standard deviation of .29, while the mean score for the expository group was .37 with a standard deviation of .29. The mean difference of similarity scores between the two groups was also very samil (.06). On this particular test, the expository group achieved a higher mean similarity score, though it was far from being statistically significant. The effect size of this test was -.21 which indicates a small magnitude of difference. Based on the data regarding the tests of group differences on the knowledge structure tests, the null hypothesis was not rejected. That is, there were no statistically significant differences between the problem-solving and expository groups on the scores of the two measures of knowledge structure. The small observed effects on the two submeasures were inconsistent and also suggested no overall difference in structure between the two treatment groups.

CONCLUSIONS

Limitations on the validity of the study must be considered carefully. Claims for internal validity must be qualified because of the lack of random assignment of subjects to treatments. Flausible grounds for the equivalence of the treatment groups were presented, but random assignment is the best safeguard against differential selection problems. Mortality was high between the pretest and two sets of posttests (14% and 21%). Even though statistical equivalence in terms of pretest scores was maintained, the subject losses warrant caution in interpreting the results. Instrument reliability was an issue. The internal consistency of the knowledge acquisition test was acceptable but not as high as desired. Regarding the knowledge structure test, no information about its reliability could be obtained due to the immaturity of this measurement field. Strong claims for external validity cannot be made given the social context of the schools, the limited scope of the subject matter, the characteristics of the students, the selection of the teachers, and the brief duration of the treatments. As with much instructional research, external validity can be established only in the context of a set of replications. Similarly, internal validity issues will also be clarified in the context of replicative work. The validity of the findings of this study must be assessed in light of future related studies.

Connections can be made between the findings of the study reported here and other studies. Schmidt (1982) observed in a laboratory experiment that problem-solving experience before exposure to new medical information resulted in better reproduction of the new information. Adams, Kasserman, Yearwood, Perfetto, Bransford, and Franks (1988) and Sherwood, Kinzer, Bransford, and Franks (1986) also demonstrated in laboratory experiments the positive contribution of problem-oriented learning for better knowledge access which presupposes effective knowledge acquisition. The findings of the experiment reported here, which showed the superior effectiveness of problem-solving instruction when compared with expository instruction for knowledge acquisition and retention, are fairly consistent with previous research findings. Moreover, the fact that the present study was conducted in real-life classroom settings extends the findings of the earlier work into other social contexts.

In contrast, the finding that there were no meaningful differences between the two instructional treatment groups in knowledge structuring revealed an inconsistency with the advocacy arguments which have recommended problem-solving instruction as a means to develop better knowledge stucture in students' memories (e.g., VanSickle & Hoge, 1991; Voss et al., 1983). Given the limitations of the measure of knowledge structure employed in this study, however, this judgment must remain open to question until more data are available.

The primary intellectual significance of the present inquiry lies in the fact that it was an attempt to initiate empirical investigations from a cognitive-psychological perspective about the relationships between problem-solving instruction and effective learning of subject matter knowledge in classrooms. Also, this research might stimulate more extensive applications of cognitive psychological findings in the field of social studies education. As more studies of this nature are made, social studies educators could acquire practical insights for instructional development and classroom practice.

This study also might be significant with respect to conventional social studies teacher wisdom. Several studies (e.g., McKee, 1988; Onosko, 1989; Shaver et al., 1979) have indicated that two beliefs are prevalent among social studies teachers regarding the relationship between teaching for higher-order thought and subject matter knowledge: (1) knowledge acquisition must precede higher-order thought, and (2) we must choose between knowledge acquisition and thinking skills development goals. However, the results of this inquiry cast doubt on these teacher beliefs. The findings of the present study strongly suggest that effective acquisition of history and social science knowledge and the development of higher-cognitive skills are compatible and practically feasible.

Ultimately, social studies educators must answer the question: Is problem-solving instruction worthy of use in high school social studies classrooms? Judgment cannot be passed on the evidence of one study alone. However, this study should encourage social studies educators to reconsider instruction for higher-order thought and social studies knowledge in light of cognitive psychological research and theory. Such reconsideration will prompt needed research and development regarding the usefulness of problem-solving instruction for teaching high school social studies.

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